United States Department of Agriculture

Weed Risk Assessments as Tools for Categorizing and Quantifying the Invasiveness of Plant Species

Tony Koop
(Plant Ecologist, Risk Analyst)
USDA-APHIS-PPQ-Plant Epidemiology & Risk Analysis Laboratory

FICMNEW
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Risk Assessment can help Identify & Characterize Invasive Species

RA - An evaluation of the likelihood of an adverse event (entry, establishment, spread) & its potential consequences

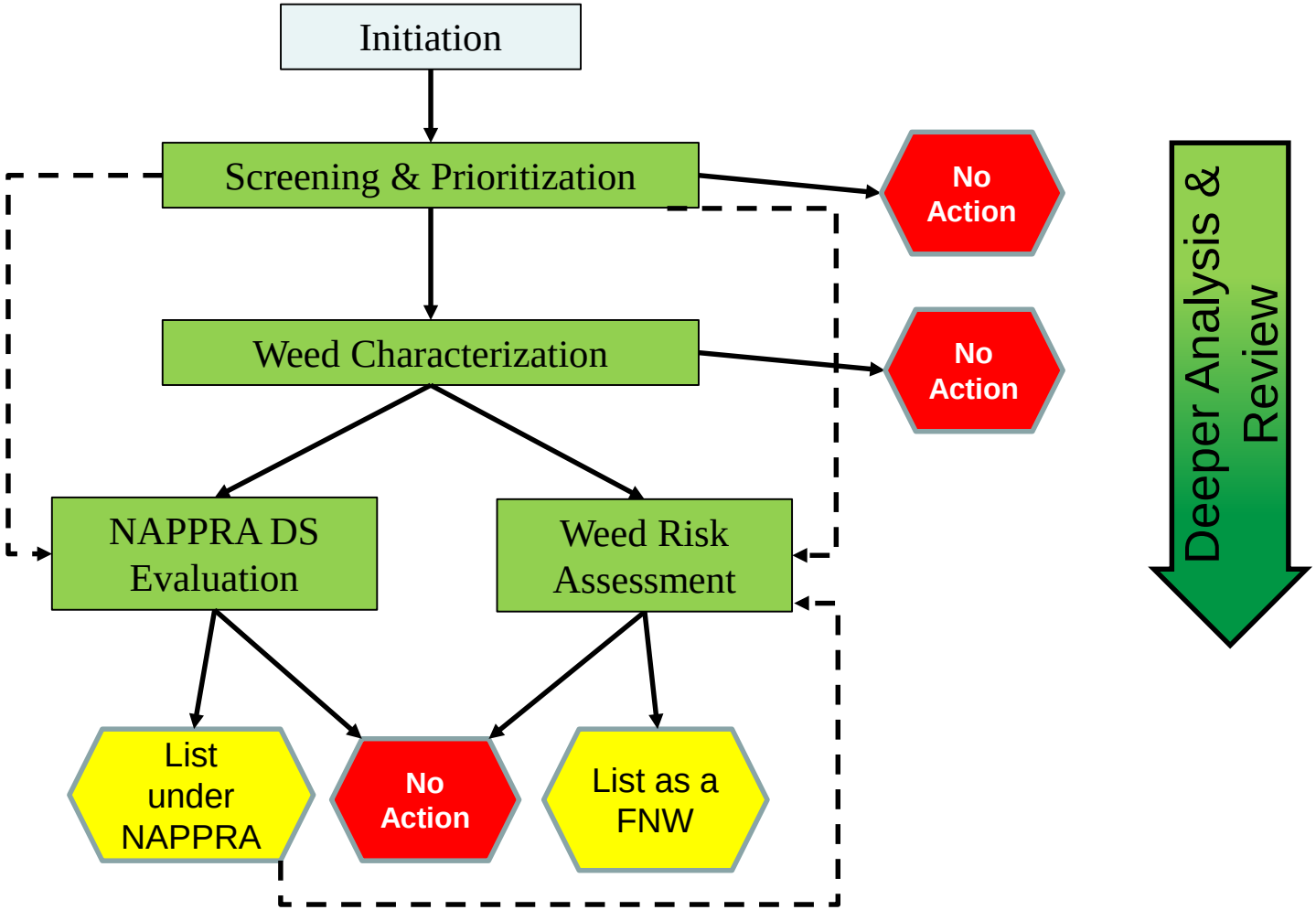
→ Systematic method

→ Informed management decisions

Wide Range of Weed Assessment Tools

- Diverse needs led to different processes
- Vary in ..
  - Goals (predictive, descriptive)
  - Kinds of questions
    - (e.g., yes/no, multiple choice, open)
  - Factors considered (e.g., entry, climate match)
  - Structure (e.g., checklist, decision tree, narrative)
  - Scoring (e.g., multiplicative, additive)

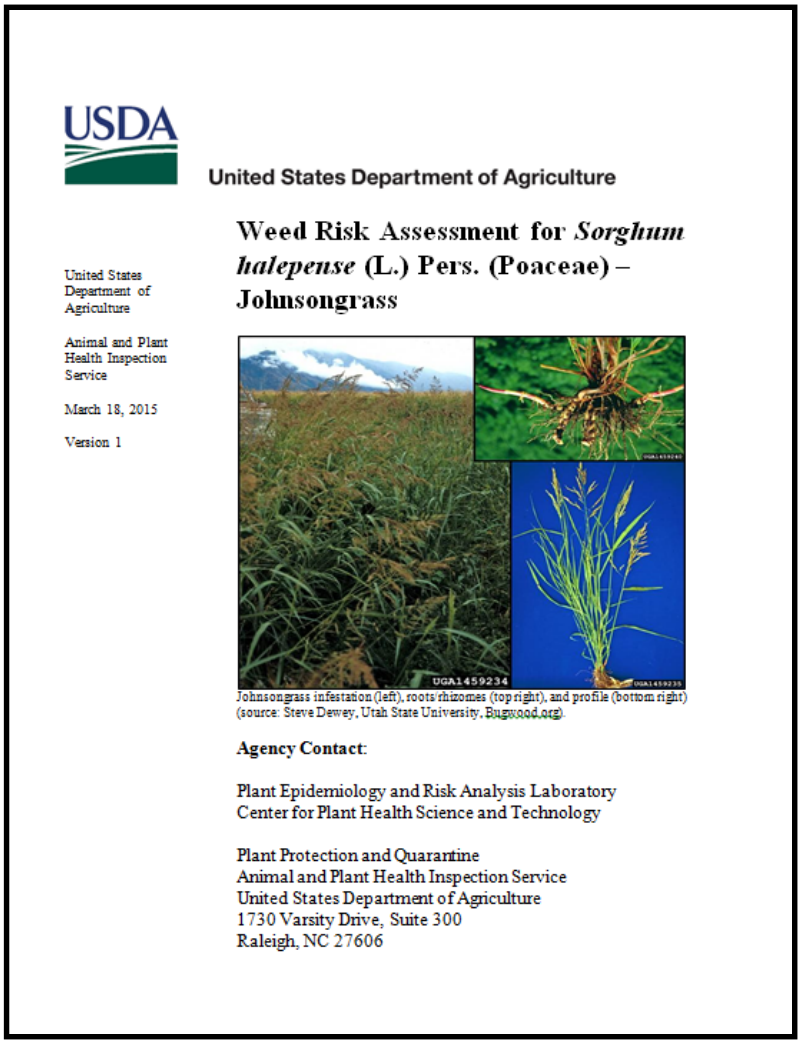
PERAL: Tiered Weed Risk Assessment



The PPQ Weed Risk Assessment

- Semi-quantitative assessment
- Species risk profile
- Predictive model
  - Validated with U.S. species

- The final product
  - ❖ 5-6 page summary
  - ❖ References
  - ❖ Appendices of the questions, answers, uncertainty, and evidence



USDA
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Animal and Plant Health Inspection Service

March 18, 2015

Version 1

Weed Risk Assessment for *Sorghum halepense* (L.) Pers. (Poaceae) – Johnsongrass

Johnsongrass infestation (left), roots/rhizomes (top right), and profile (bottom right) (source: Steve Dewey, Utah State University, Bugwood.org).

Agency Contact:

Plant Epidemiology and Risk Analysis Laboratory
Center for Plant Health Science and Technology

Plant Protection and Quarantine
Animal and Plant Health Inspection Service
United States Department of Agriculture
1730 Varsity Drive, Suite 300
Raleigh, NC 27606

Style of the assessment

- Mostly Yes/No questions; a few multiple choice
- Record uncertainty: negligible, low, moderate, high, max
- Evidence, supporting documents, and reasoning are recorded for each

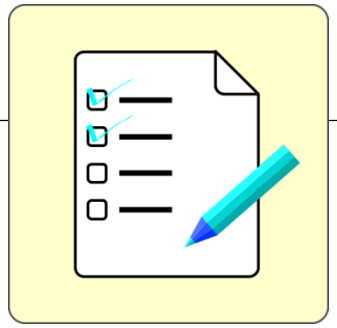
2	Question ID	Question	Answer	Uncer-tainty	Score	Notes (and references)
3						
4						
5	**Establishment / Spread Potential**					
6	ES-1	Select one: (A) Introduced elsewhere long ago (>75 years) but not escaped; (B) Introduced recently (<75 years) but not escaped; (C) Never introduced elsewhere; (D) Escaped/Casual; (E) Naturalized; (F) Invader.			???	
7	ES-2	Is the species highly domesticated (y, n, or ?).			???	
8	ES-3	Congeneric weed (y, n, or ?).			???	
9	ES-4	Shade tolerant at some stage of life cycle (y, n, or ?).			???	
10	ES-5	Climbing or smothering growth habit (y, n, or ?).			???	
11	ES-6	Forms dense thickets (y, n, or ?).			???	
12	ES-7	Aquatic (y, n, or ?).			???	
13	ES-8	Grass (y, n, or ?).			???	
14	ES-9	Nitrogen-fixing woody plant (y, n, or ?).			???	
15	ES-10	Produces viable seed or spores (y, n, or ?).			???	
16	ES-11	Self-compatible or apomictic (y, n, or ?).			???	
17	ES-12	Requires specialist pollinators (y, n, or ?).			???	
18	ES-13	Minimum generative time (A) less than 1 (multiple generations per year), (B) 1 year (annual-1 gen per year),			???	
19	ES-14	Prolific seed/spore production (see scoring guide) (y, n, or ?).			???	
20	ES-15	Propagules likely to be dispersed unintentionally by people (y, n, or ?).			???	
21	ES-16	Propagules likely to disperse in trade as contaminants and hitchhikers (y, n, or ?).			???	
22	ES-17	No. natural dispersal vectors	0		-4	
23	ES-17a	Propagules adapted to wind dispersal (y, n, or ?).			???	
24	ES-17b	Propagules water dispersed (y, n, or ?).			???	
25	ES-17c	Propagules bird dispersed (y, n, or ?).			???	
26	ES-17d	Propagules dispersed by other animals (externally) (y, n, or ?).			???	
27	ES-17e	Propagules dispersed by other animals (internally) (y, n, or ?).			???	
28	ES-18	Evidence that a persistent propagule bank (e.g., seed bank)			???	
29	ES-19	Tolerates/benefits from mutilation, cultivation or fire (y, n, or ?).			???	
30	ES-20	Is resistant to some herbicides or has potential to acquire			???	
31	ES-21	Number of USDA cold hardiness zones suitable for survival	0		-1	
32	ES-22	Number of climate types suitable for survival	0		-2	
33	ES-23	Number of precipitation bands suitable for survival	0		-1	
34						
35						
36	**Impact Potential**					
37	*General impacts*					
38	Imp-G1	Allelopathic (y, n, or ?).			???	

Risk Elements in the WRA

- Establishment / Spread Potential (23)
- Impact Potential (18)
- Geographic Potential (36)
- Entry Potential (14)

Predictive model

Uncertainty Analysis



Predictive Model

Establishment / Spread Potential

Species traits
- Aquatic, N2 fixer, Grass

Reproductive
- Viable seeds, Selfing

Spread
- Human-assisted
- Natural

Persistence
- Seed banks, Herbicide resistance

Impact Potential

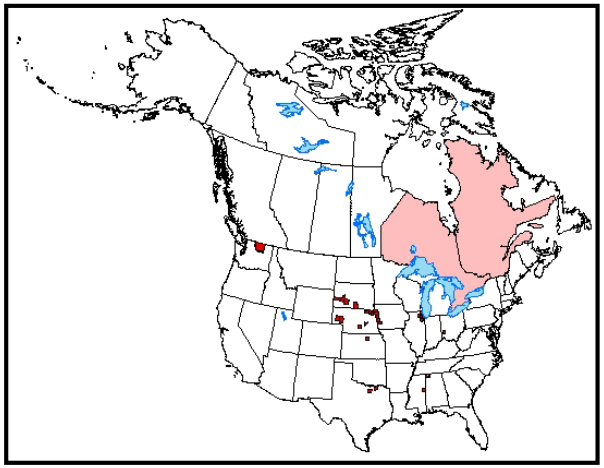
Natural Systems
- Change species diversity
- Likely to affect T&E species

Anthropogenic Systems
- Reduce access

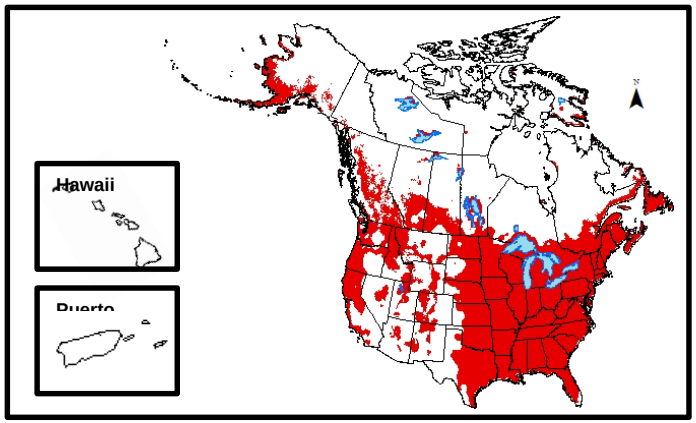
Production Systems
- Reduce yield
- Toxic to livestock

The WRA's core analyses & results

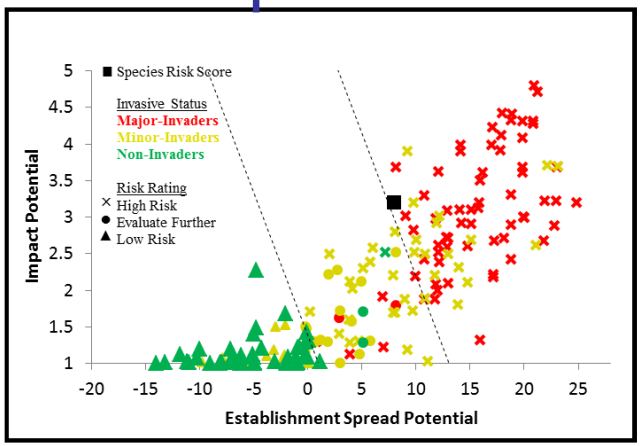
Current distribution



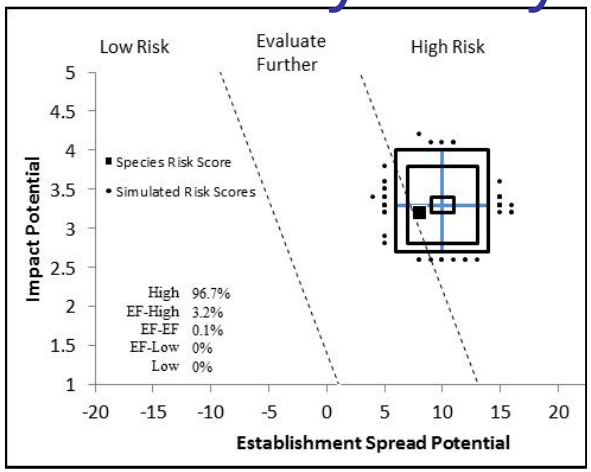
Geographic potential



Risk potential

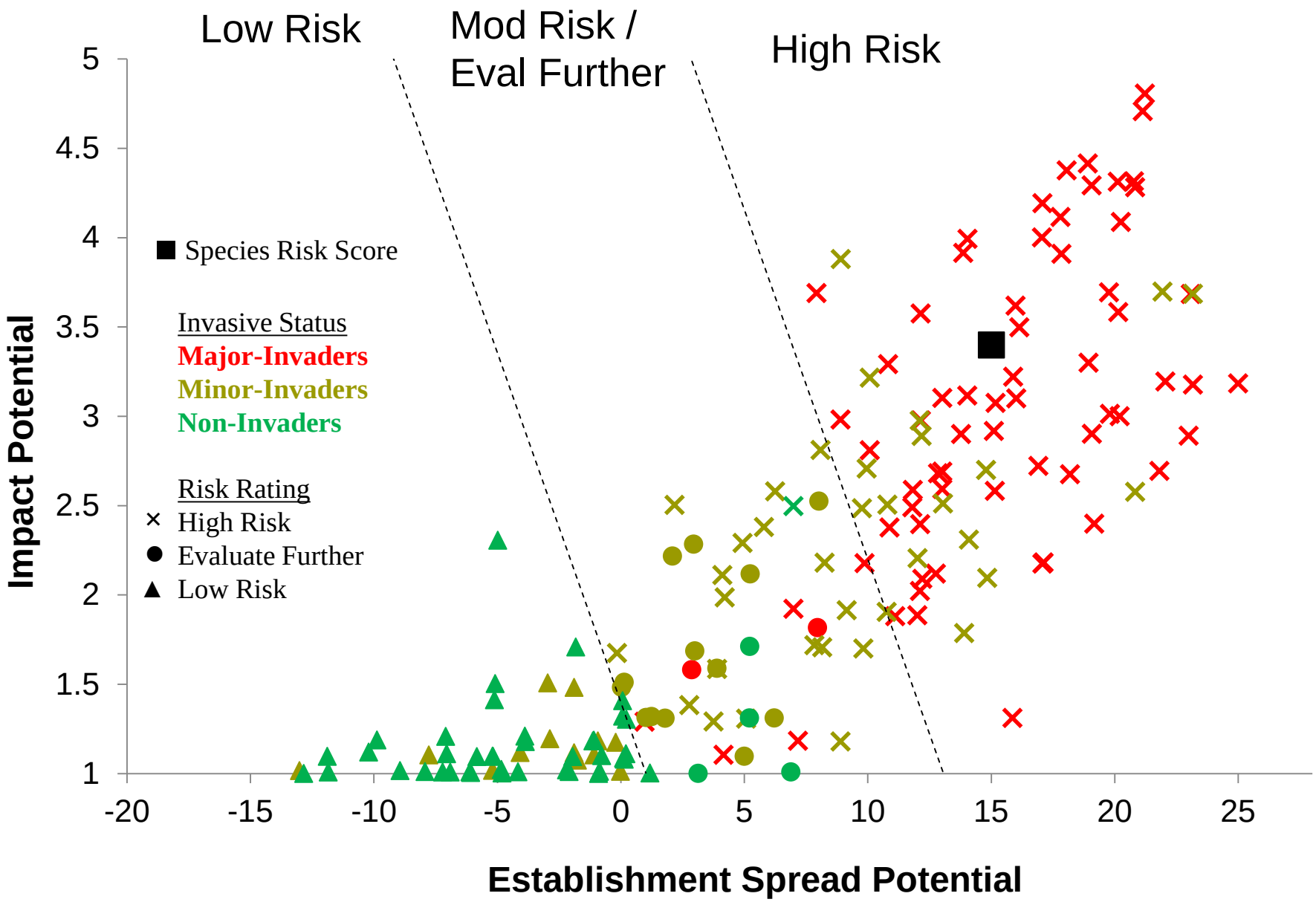


Uncertainty analysis



1) Risk Potential

- Answer questions for Establishment/Spread & Impact
- Calculate risk scores
  - Higher values, indicate greater capacity
- Describe the final outcome
  - Low Risk, Evaluate Further, High Risk
- Species with moderate scores (EF) → secondary screening tool
  - Low Risk, Moderate Risk, High Risk


Low Risk
Mod Risk / Eval Further
High Risk
Species Risk Score
Invasive Status
Major-Invaders
Minor-Invaders
Non-Invaders
Risk Rating
High Risk
Evaluate Further
Low Risk
Impact Potential
Establishment Spread Potential
5
4.5
4
3.5
3
2.5
2
1.5
1
-20
-15
-10
-5
0
5
10
15
20
25

Model Performance

(validation dataset, N=102)

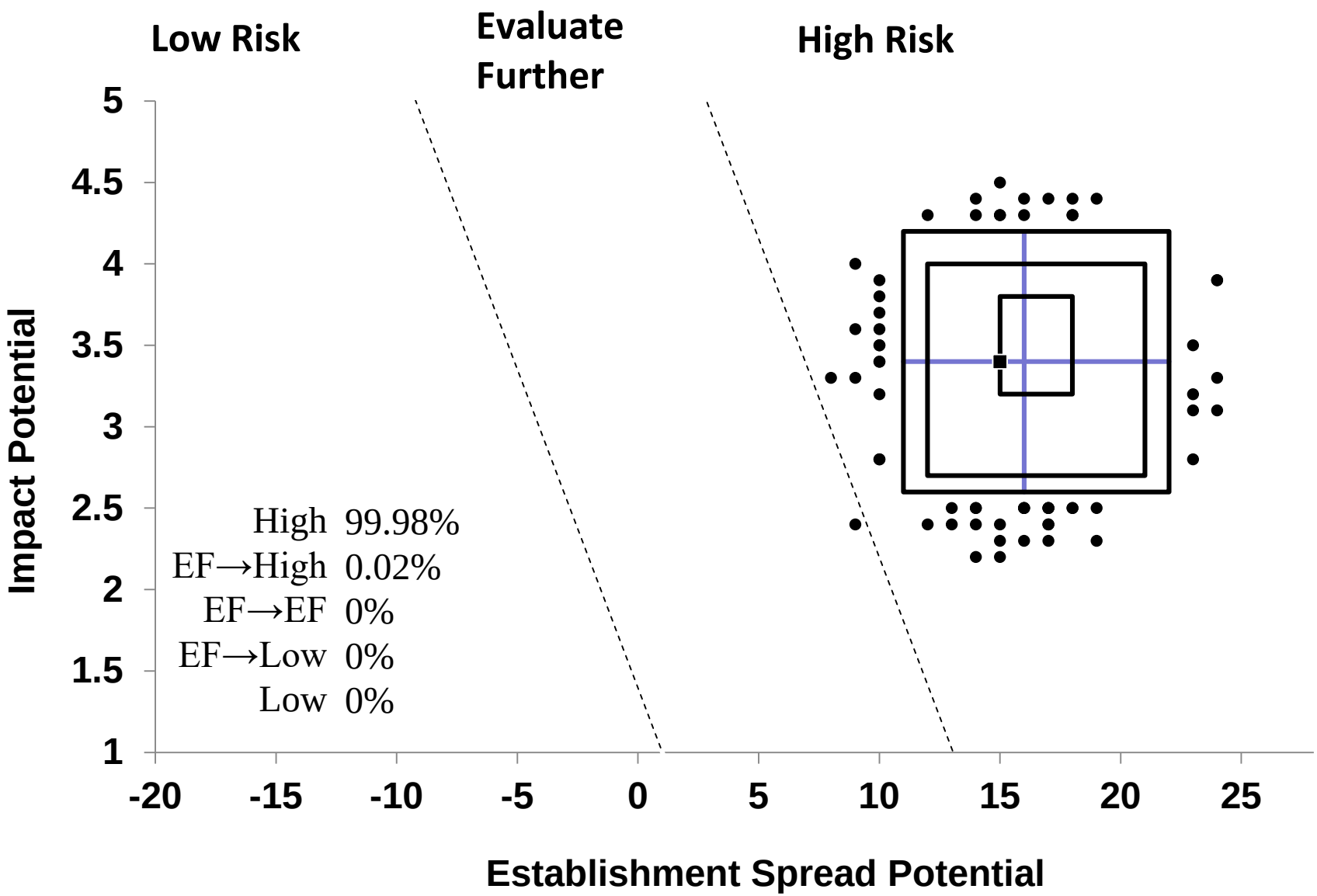
	Accuracy		Error	
Test	Maj-Invaders (True +)	Non-Invaders (True -)	Maj-Invaders (False +)	Non-Invaders (False-)
US – PPQ WRA	0.941	0.971	0.000	0.000
US - Aus WRA	0.971	0.794	0.088	0.000
Mean (8 other AUS tests)	0.936	0.715	0.164	0.022

- Overall accuracy is higher than the Australian WRA
- Non-invader and major-invader performance similar

Koop, A., L. Fowler, L. Newton, and B. Caton. 2012. Development and validation of a weed screening tool for the United States. Biological Invasions 14(2):273-294.

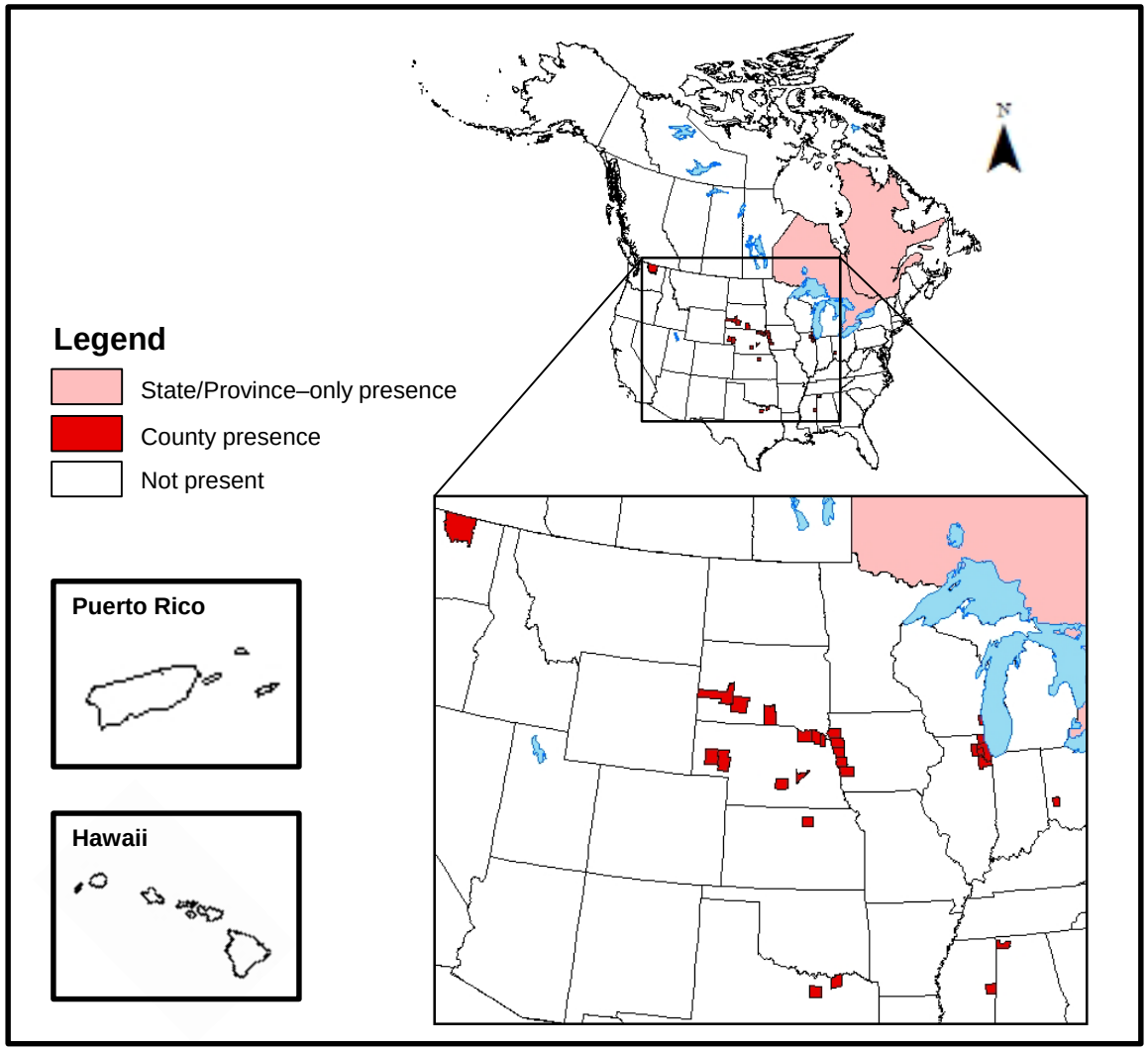
2) Uncertainty analysis

- Summarize & describe uncertainty for each risk element
- Evaluate the sensitivity of the risk scores to uncertainty using a Monte Carlo simulation
  - what would the risk score be if…
  - N = 5,000



Caton, B. P., A. L. Koop, L. Fowler, L. Newton, and L. Kohl. 2018. Quantitative uncertainty analysis for a weed risk assessment model. Risk Analysis:1-16. DOI: 10.1111/risa.12979.

3) Current U.S. Distribution

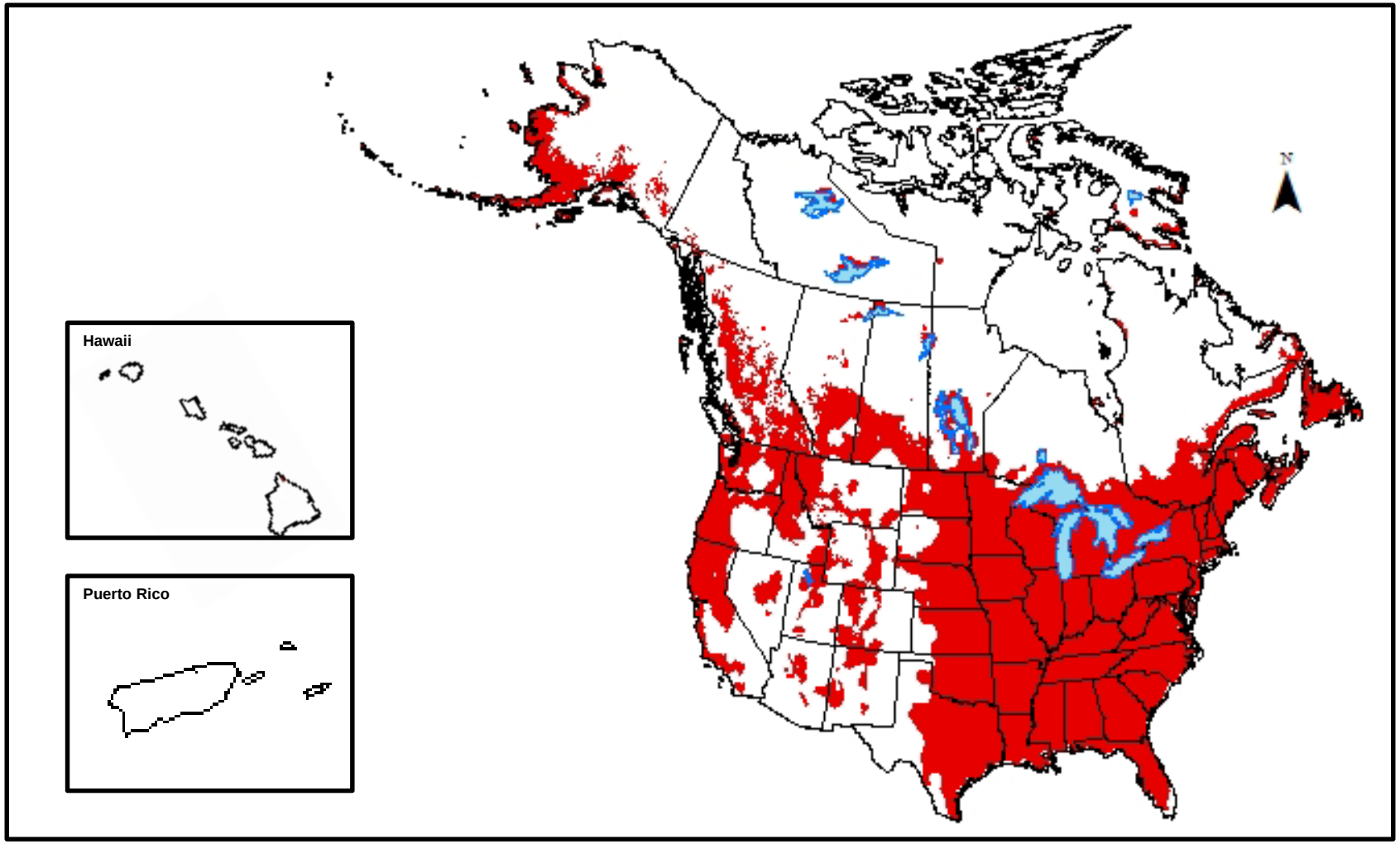


USDA Plants
BONAP
EDDMapS
iNaturalist
Herbaria

Other sources

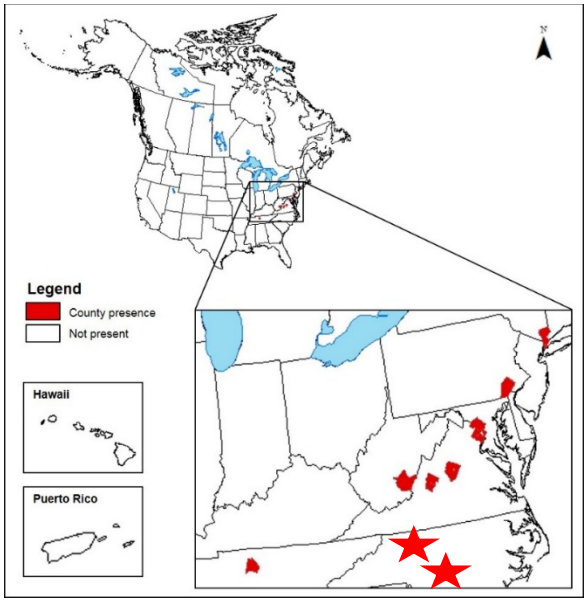
4) Geographic potential

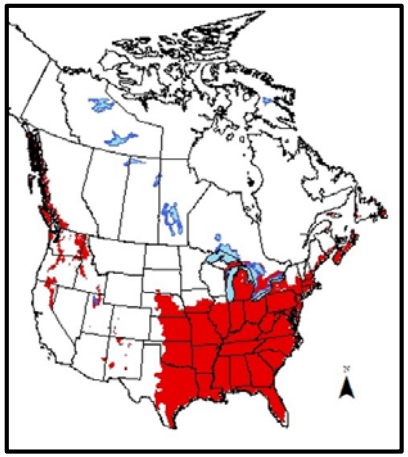
- Geo potential evaluated separately
- Simple analysis that matches on and overlays
  - Plant hardiness zones
  - Annual precipitation
  - Climate classes

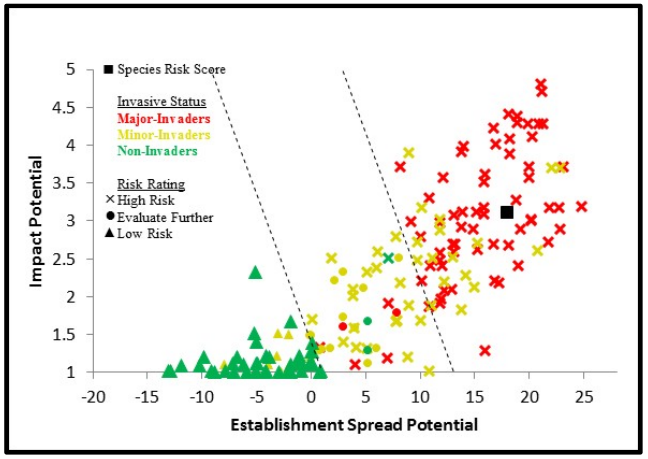


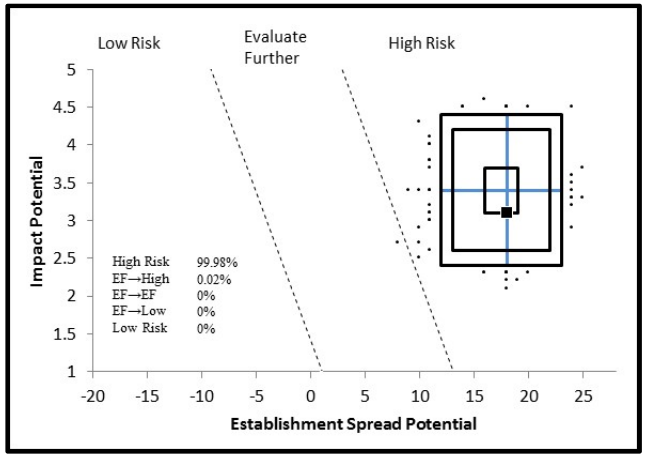
Magarey, et. al. 2017. Comparison of four modeling tools for the prediction of potential distribution for non-indigenous weeds in the United States. Biological Invasions:1-16: DOI: 10.1007/s10530-10017-11567-10531.

Corydalis incisa: A new invader









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Thank You

Tony Koop
Anthony.L.Koop@aphis.USDA.gov
(contact for publication requests)

To report weed & invasive plant concerns
Weeds@aphis.USDA.gov